CLAIMS

1. A method for treating a subject, comprising:

applying an electrical current to a hepatic portal vein of the subject; and

configuring the current so as to increase glucose uptake by tissue of the subject.

2. The method according to claim 1, wherein configuring the current comprises configuring the current so as to increase the glucose uptake by a physiological mechanism not mediated by insulin.

3. The method according to claim 1, wherein configuring the current comprises configuring the current so as to increase the glucose uptake by a physiological mechanism mediated by insulin.

4. The method according to claim 1, wherein applying the current comprises applying the current only at certain predetermined times of the day.

5. The method according to claim 1, comprising receiving a command from the subject, wherein applying the current comprises applying the current responsively to receiving the command.

6. The method according to claim 1, wherein configuring the current comprises configuring the current to stimulate afferent nerve terminals embedded in a site selected from the list consisting of: a wall of the portal vein, and a liver of the subject.

7. The method according to claim 1, wherein configuring the current comprises configuring the current to minimize artificially-induced activation of muscle tissue of the portal vein.

8. The method according to claim 1, wherein applying the current comprises:

selecting a subject suffering from a condition selected from the list consisting of: obesity, type I diabetes, type II diabetes, heart disease, and hypertension; and

applying the current to the portal vein of the selected subject.

9. The method according to claim 1, wherein configuring the current comprises configuring the current to have a frequency of between about 0.1 Hz and about 5 Hz.

10. The method according to claim 1, wherein configuring the current comprises configuring the current to have a frequency of between about 5 Hz and about 100 Hz.

11. The method according to claim 1, wherein configuring the current comprises configuring the current to have a frequency of between about 100 Hz and about 1 kHz.

12. The method according to claim 1, wherein configuring the current comprises configuring the current to have an amplitude of between about 0.1 and about 1 milliamps.

13. The method according to claim 1, wherein configuring the current comprises configuring the current to have an amplitude of between about 1 and about 15 milliamps.

14. The method according to claim 1, wherein configuring the current comprises configuring the current to have an amplitude of between about 15 and about 20 milliamps.

15. The method according to claim 1, wherein applying the current comprises applying the current not responsively to a detection of eating by the subject.

16. The method according to claim 1, wherein applying the current comprises applying one or more electrodes to an external surface of the portal vein, and driving the electrodes to apply the current.

17. The method according to any one of claims 1-16, wherein applying the current comprises placing one or more electrodes in the portal vein, and driving the one or more electrodes to apply the current.

18. The method according to claim 17, wherein placing the electrodes comprises:

making an opening in a mesenteric vein of the subject that empties into a superior mesenteric vein of the subject;

inserting at least one of the electrodes through the opening; and

advancing the at least one of the electrodes through the mesenteric vein and the superior mesenteric vein until a distal region of the at least one of the electrodes reaches the portal vein.

19. The method according to any one of claims 1-16, wherein applying the current comprises applying the current at least intermittently during a period having a duration of at least 3 days.

20. The method according to claim 19, wherein applying the current comprises applying the current at least intermittently during a period having a duration of at least one month.

21. The method according to claim 1, wherein applying the current comprises detecting an indication of a blood glucose concentration of the subject, and, responsive thereto, applying the current.

22. The method according to claim 1, wherein applying the current comprises detecting an indication of eating by the subject, and, responsive thereto, applying the current.

23. The method according to claim 21 or claim 22, wherein detecting the indication comprises:

sensing an electrical signal generated by a portoarterial glucose sensor of the subject; and

detecting the indication by analyzing the signal.

24. The method according to claim 22, wherein detecting the indication comprises measuring an indication of a concentration of at least one blood constituent in the portal vein of the subject, the constituent selected from the list consisting of: glucose, carbohydrate, fat, and protein.

25. A method comprising:

sensing an electrical signal generated by a portoarterial glucose sensor of a subject;

analyzing the signal; and

responsive to the analyzing, detecting eating by the subject.

26. The method according to claim 25, comprising reducing an appetite of the subject responsively to detecting the eating.

27. The method according to claim 25, comprising:

responsively to detecting the eating, applying an electrical stimulating signal to at least one site selected from the list consisting of: a site in a vicinity of a colon of the subject, and a site in a vicinity of a distal small intestine of the subject; and

configuring the stimulating signal to stimulate L-cells to increase secretion of at least one hormone selected from the list consisting of: glucagon-like-peptide-1 (GLP-1) and peptide YY (PYY).

28. The method according to claim 25, comprising:

responsively to detecting the eating, applying an electrical inhibiting signal to at least one site selected from the list consisting of: a site in a vicinity of a stomach of the subject, and a site in a vicinity of a duodenum of the subject; and

configuring the inhibiting signal to inhibit secretion of ghrelin.

29. The method according to claim 25, comprising:

responsively to detecting the eating, applying a vagal electrical signal to a vagus nerve of the subject; and

configuring the vagal signal to stimulate secretion of at least one hormone selected from the list consisting of: glucagon-like-peptide-1 (GLP-1) and peptide YY (PYY)

30. The method according to claim 25, comprising:

responsively to detecting the eating, applying a vagal electrical signal to a vagus nerve of the subject; and

configuring the vagal signal to inhibit secretion of ghrelin.

31. The method according to claim 25, comprising applying a pancreas electrical signal to a pancreas of the subject responsively to detecting the eating.

32. The method according to claim 25, wherein analyzing the signal comprises determining an indication of a quantity of glucose recently absorbed by a small intestine of the subject during the eating, and wherein detecting the eating comprises detecting the eating by analyzing the indication.

33. The method according to any one of claims 25-32, wherein sensing the signal comprises sensing electrical activity of a hepatic portal vein of the subject.

34. The method according to claim 33, wherein sensing the signal comprises applying one or more electrodes to an external surface of the portal vein, and sensing the signal using the electrodes.

35. The method according to claim 33, wherein analyzing the signal comprises detecting a decrease in the electrical activity of the portal vein.

36. The method according to claim 33, wherein analyzing the signal comprises detecting an increase in the electrical activity of the portal vein.

37. The method according to claim 33, wherein analyzing the signal comprises detecting changes in heights of different measured peaks of the electrical activity of the portal vein.

38. The method according to claim 33, wherein analyzing the signal comprises detecting changes in relative timing of different peaks in the electrical activity of the portal vein.

39. The method according to claim 33, wherein sensing the electrical activity comprises sensing electrical activity of afferent nerve fibers that innervate the portal vein.

40. The method according to claim 33, wherein sensing the signal comprises placing one or more electrodes in the portal vein, and sensing the signal using the electrodes.

41. The method according to claim 40, wherein placing the electrodes comprises:

making an opening in a mesenteric vein of the subject that empties into a superior mesenteric vein of the subject;

inserting at least one of the electrodes through the opening; and

advancing the at least one of the electrodes through the mesenteric vein and the superior mesenteric vein until a distal region of the at least one of the electrodes reaches the portal vein.

42. The method according to any one of claims 25-32, wherein sensing the signal comprises sensing electrical activity of a hepatic branch of a vagus nerve of the subject.

43. The method according to claim 42, wherein sensing the electrical activity the hepatic branch comprises sensing afferent impulses in the hepatic branch generated by the portoarterial glucose sensor.

44. The method according to claim 42, comprising:

responsively to detecting the eating, applying a vagal electrical signal to the hepatic branch; and

configuring the vagal signal to reduce an appetite of the subject.

45. The method according to claim 44, wherein configuring the vagal signal comprises configuring the vagal signal to mimic natural afferent nerve signals generated by the portoarterial glucose sensor.

46. A method for detecting eating by a subject, comprising:

measuring an indication of a concentration of at least one blood constituent in a hepatic portal vein of the subject, the constituent selected from the list consisting of: glucose, carbohydrate, fat, and protein;

analyzing the indication of the concentration; and

responsive to the analyzing, detecting the eating.

47. The method according to claim 46, wherein measuring the indication of the concentration comprises measuring the indication of the concentration using a chemical blood analysis technique.

48. The method according to claim 46, wherein analyzing the indication of the concentration comprises detecting an indication of a composition of food eaten by the subject, responsive to the analyzing.

49. The method according to any one of claims 46-48, wherein measuring the indication of the concentration comprises measuring the indication of the concentration using a non-chemical blood analysis technique.

50. The method according to claim 49, wherein measuring the indication of the concentration comprises measuring the indication of the concentration using near-infrared or infrared absorption spectroscopy.

51. The method according to claim 49, wherein measuring the indication of the concentration comprises measuring acoustic reflections from blood in the portal vein.

52. The method according to any one of claims 46-48, wherein measuring the indication of the concentration comprises measuring a rate of blood flow within the hepatic portal vein.

53. The method according to claim 52, wherein measuring the rate of blood flow comprises measuring the rate of blood flow using a flow meter.

54. The method according to claim 52, wherein measuring the rate of blood flow comprises measuring a change in impedance between electrodes placed on an external surface of the portal vein.

55. A method comprising:

sensing an electrical signal generated by a portoarterial glucose sensor of a subject;

analyzing the signal; and

responsive to the analyzing, detecting an indication of a blood glucose concentration of the subject.

56. The method according to claim 55, comprising reducing an appetite of the subject responsively to detecting the indication of the blood glucose concentration.

57. The method according to claim 55, comprising reducing the blood glucose concentration responsively to detecting the indication of the blood glucose concentration.

58. The method according to claim 55, comprising:

responsively to detecting the indication of the blood glucose concentration, applying an electrical stimulating signal to at least one site selected from the list consisting of: a site in a vicinity of a colon of the subject, and a site in a vicinity of a distal small intestine of the subject; and

configuring the stimulating signal to stimulate L-cells to increase secretion of at least one hormone selected from the list consisting of: glucagon-like-peptide-1 (GLP-1) and peptide YY (PYY).

59. The method according to any one of claims 55-58, comprising increasing a blood insulin level responsively to detecting the blood glucose concentration.

60. The method according to claim 59, wherein increasing the blood insulin level comprises supplying insulin to a blood circulation of the subject from an insulin pump.

61. The method according to claim 59, wherein increasing the blood insulin level comprises applying a pancreatic electrical signal to a pancreas of the subject, and configuring the pancreatic signal to increase insulin secretion.

62. The method according to claim 59, wherein increasing the blood insulin level comprises applying a vagal electrical signal to a vagus nerve of the subject, and configuring the vagal signal to cause an increase in insulin secretion by a pancreas of the subject.

63. The method according to any one of claims 55-58, wherein sensing the signal comprises sensing electrical activity of a hepatic portal vein of the subject.

64. The method according to claim 63, wherein analyzing the signal comprises detecting a decrease in the electrical activity of the portal vein.

65. The method according to claim 63, wherein analyzing the signal comprises detecting an increase in the electrical activity of the portal vein.

66. The method according to claim 63, wherein analyzing the signal comprises detecting changes in heights of different measured peaks of the electrical activity of the portal vein.

67. The method according to claim 63, wherein analyzing the signal comprises detecting changes in relative timing of different peaks in the electrical activity of the portal vein.

68. The method according to claim 63, wherein sensing the electrical activity comprises sensing electrical activity of afferent nerve fibers that innervate the portal vein.

69. The method according to claim 63, wherein sensing the signal comprises applying one or more electrodes to an external surface of the portal vein, and sensing the signal using the electrodes.

70. The method according to claim 63, wherein sensing the signal comprises placing one or more electrodes in the portal vein, and sensing the signal using the one or more electrodes.

71. The method according to claim 70, wherein placing the electrodes comprises:

making an opening in a mesenteric vein of the subject that empties into a superior mesenteric vein of the subject;

inserting at least one of the electrodes through the opening; and

advancing the at least one of the electrodes through the mesenteric vein and the superior mesenteric vein until a distal region of the at least one of the electrodes reaches the portal vein.

72. The method according to any one of claims 55-58, wherein sensing the signal comprises sensing electrical activity of a hepatic branch of a vagus nerve of the subject.

73. The method according to claim 72, wherein sensing the electrical activity the hepatic branch comprises sensing afferent impulses in the hepatic branch generated by the portoarterial glucose sensor.

74. The method according to claim 72, comprising:

responsively to detecting the indication of the blood glucose concentration, applying a vagal electrical signal to the hepatic branch; and

configuring the vagal signal to reduce an appetite of the subject.

75. The method according to claim 74, wherein configuring the vagal signal comprises configuring the vagal signal to mimic natural afferent nerve signals generated by the portoarterial glucose sensor.

76. A method for stimulating a vein of a subject, comprising:

placing, around an external surface of the vein, a wire shaped so as to define an arc of between about 270 and about 359 degrees; and

driving an electrical current through the wire, so as to stimulate the vein.

77. The method according to claim 76, wherein the vein includes a hepatic portal vein, and wherein placing the wire comprises placing the wire around the external surface of the portal vein.

78. The method according to claim 76, wherein the electrode includes a removable curved needle, and wherein placing the wire comprises:

using the needle to draw the electrode around the external surface of the vein beneath at least a portion of connective tissue surrounding the vein; and

removing the needle after completion of the drawing.

79. A method for sensing electrical activity of a vein of a subject, comprising:

placing, around an external surface of the vein, a wire shaped so as to define an arc of between about 270 and about 359 degrees; and

sensing the electrical activity of the vein, using the wire.

80. The method according to claim 79, wherein the vein includes a hepatic portal vein, and wherein placing the wire comprises placing the wire around the external surface of the portal vein.

81. The method according to claim 79, wherein the electrode includes a removable curved needle, and wherein placing the wire comprises:

using the needle to draw the electrode around the external surface of the vein beneath at least a portion of connective tissue surrounding the vein; and

removing the needle after completion of the drawing.

82. A method for placing an electrode in a hepatic portal vein of a subject, the method comprising:

making an opening in a mesenteric vein of the subject that empties into a superior mesenteric vein of the subject;

inserting the electrode through the opening; and

advancing the electrode through the mesenteric vein and the superior mesenteric vein until a distal region of the electrode reaches the portal vein.

83. The method according to claim 82, comprising securing a proximal end of the electrode to the mesenteric vein in a vicinity of the opening.

84. The method according to claim 82, comprising tying off the mesenteric vein at a site of the mesenteric vein upstream from the opening.

85. Apparatus for treating a subject, comprising:

one or more electrodes, adapted to be applied to a hepatic portal vein of the subject; and

a control unit, adapted to:

drive the electrodes to apply an electrical current to the portal vein, and

configure the current to increase glucose uptake by tissue of the subject.

86. The apparatus according to claim 85, wherein the control unit is adapted to configure the current so as to increase the glucose uptake by a physiological mechanism not mediated by insulin.

87. The apparatus according to claim 85, wherein the control unit is adapted to configure the current so as to increase the glucose uptake by a physiological mechanism mediated by insulin.

88. The apparatus according to claim 85, wherein the control unit is adapted to drive the electrodes to apply the current only at certain predetermined times of the day.

89. The apparatus according to claim 85, comprising an input unit, adapted to receive a command from the subject, wherein the control unit is adapted to drive the electrodes to apply the current responsively to the received command.

90. The apparatus according to claim 85, wherein the control unit is adapted to configure the current to stimulate afferent nerve terminals embedded in a site selected from the list consisting of: a wall of the portal vein, and a liver of the subject.

91. The apparatus according to claim 85, wherein the control unit is adapted to configure the current to minimize artificially-induced activation of muscle tissue of the portal vein.

92. The apparatus according to claim 85, wherein the control unit is adapted to configure the current to have a frequency of between about 0.1 Hz and about 5 Hz.

93. The apparatus according to claim 85, wherein the control unit is adapted to configure the current to have a frequency of between about 5 Hz and about 100 Hz.

94. The apparatus according to claim 85, wherein the control unit is adapted to configure the current to have a frequency of between about 100 Hz and about 1 kHz.

95. The apparatus according to claim 85, wherein the control unit is adapted to configure the current to have an amplitude of between about 0.1 and about 1 milliamps.

96. The apparatus according to claim 85, wherein the control unit is adapted to configure the current to have an amplitude of between about 1 and about 15 milliamps.

97. The apparatus according to claim 85, wherein the control unit is adapted to configure the current to have an amplitude of between about 15 and about 20 milliamps.

98. The apparatus according to claim 85, wherein the control unit is adapted to drive the electrodes to apply the current not responsively to a detection of eating by the subject.

99. The apparatus according to any one of claims 85-98, wherein the electrodes are adapted to be applied to an external surface of the portal vein.

100. The apparatus according to claim 99, wherein each of the electrodes comprises a wire shaped so as to define an arc of between about 270 and about 359 degrees, and wherein the electrodes are adapted to be applied around the external surface of the portal vein.

101. The apparatus according to any one of claims 85-98, wherein the electrodes are adapted to be placed in the portal vein.

102. The apparatus according to claim 101, wherein the electrodes comprise an electrode lead having a distal region and a proximal end, the electrode lead adapted to be placed in the portal vein by being advanced through: (a) an opening in a mesenteric vein of the subject that empties into a superior mesenteric vein of the subject, (b) the mesenteric vein, and (c) the superior mesenteric vein, until a distal region of the electrode reaches the portal vein.

103. The apparatus according to any one of claims 85-98, wherein the control unit is adapted to apply the current at least intermittently during a period having a duration of at least 3 days.

104. The apparatus according to claim 103, wherein the control unit is adapted to apply the current at least intermittently during a period having a duration of at least one month.

105. The apparatus according to claim 85, wherein the control unit is adapted to detect an indication of a blood glucose concentration of the subject, and, responsive thereto, to drive the electrodes to apply the current.

106. The apparatus according to claim 85, wherein the control unit is adapted to detect an indication of eating by the subject, and, responsive thereto, to drive the electrodes to apply the current.

107. The apparatus according to claim 105 or claim 106, wherein the control unit is adapted to detect the indication by sensing an electrical signal generated by a portoarterial glucose sensor of the subject, and by analyzing the signal.

108. The apparatus according to claim 106, wherein the control unit is adapted to detect the indication of eating by measuring an indication of a concentration of at least one blood constituent in the portal vein of the subject, the constituent selected from the list consisting of: glucose, carbohydrate, fat, and protein.

109. Apparatus comprising:

one or more electrodes, adapted to sense an electrical signal generated by a portoarterial glucose sensor of a subject; and

a control unit, adapted to:

analyze the signal, and

responsive to the analysis, detect eating by the subject.

110. The apparatus according to claim 109, wherein the control unit is adapted to reduce an appetite of the subject responsively to detecting the eating.

111. The apparatus according to claim 109, comprising one or more signal application electrodes, adapted to be applied to at least one site selected from the list consisting of: a site in a vicinity of a colon of the subject, and a site in a vicinity of a distal small intestine of the subject, wherein the control unit is adapted to:

responsively to detecting the eating, drive the signal application electrodes to apply an electrical stimulating signal to the at least one site, and

configure the stimulating signal to stimulate L-cells to increase secretion of at least one hormone selected from the list consisting of: glucagon-like-peptide-1 (GLP-1) and peptide YY (PYY).

112. The apparatus according to claim 109, comprising one or more signal application electrodes, adapted to be applied to at least one site selected from the list consisting of: a site in a vicinity of a stomach of the subject, and a site in a vicinity of a duodenum of the subject, wherein the control unit is adapted to:

responsively to detecting the eating, drive the signal application electrodes to apply an inhibiting electrical signal to the at least one site, and

configure the inhibiting signal to inhibit secretion of ghrelin.

113. The apparatus according to claim 109, comprising one or more signal application electrodes, adapted to be applied to a vagus nerve of the subject, wherein the control unit is adapted to:

responsively to detecting the eating, drive the signal application electrodes to apply a vagal electrical signal to the vagus nerve, and

configure the vagal signal to stimulate secretion of at least one hormone selected from the list consisting of: glucagon-like-peptide-1 (GLP-1) and peptide YY (PYY).

114. The apparatus according to claim 109, comprising one or more signal application electrodes, adapted to be applied to a vagus nerve of the subject, wherein the control unit is adapted to:

responsively to detecting the eating, drive the signal application electrodes to apply a vagal electrical signal to the vagus nerve, and

configure the vagal signal to inhibit secretion of ghrelin.

115. The apparatus according to claim 109, comprising one or more signal application electrodes adapted to be applied to a pancreas of the subject, wherein the control unit is adapted to drive the signal application electrodes to apply a pancreas electrical signal to the pancreas responsively to detecting the eating.

116. The apparatus according to claim 109, wherein the control unit is adapted to determine an indication of a quantity of glucose recently absorbed by a small intestine of the subject during the eating, and to detect the eating by analyzing the indication.

117. The apparatus according to any one of claims 109-116, wherein the electrodes are adapted to be applied to a hepatic portal vein of the subject, and to sense electrical activity of the portal vein.

118. The apparatus according to claim 117, wherein the control unit is adapted to analyze the signal by detecting a decrease in the electrical activity of the portal vein.

119. The apparatus according to claim 117, wherein the control unit is adapted to analyze the signal by detecting an increase in the electrical activity of the portal vein.

120. The apparatus according to claim 117, wherein the control unit is adapted to analyze the signal by detecting changes in heights of different measured peaks of the electrical activity of the portal vein.

121. The apparatus according to claim 117, wherein the control unit is adapted to analyze the signal by detecting changes in relative timing of different peaks in the electrical activity of the portal vein.

122. The apparatus according to claim 117, wherein the electrodes are adapted to sense electrical activity of afferent nerve fibers that innervate the portal vein.

123. The apparatus according to claim 117, wherein the electrodes are adapted to be applied to an external surface of the portal vein.

124. The apparatus according to claim 123, wherein each of the electrodes comprises a wire shaped so as to define an arc of between about 270 and about 359 degrees, and wherein the electrodes are adapted to be applied around the external surface of the portal vein.

125. The apparatus according to claim 117, wherein the electrodes are adapted to be placed in the portal vein.

126. The apparatus according to claim 125, wherein the electrodes comprise an electrode lead having a distal region and a proximal end, the electrode lead adapted to be placed in the portal vein by being advanced through: (a) an opening in a mesenteric vein of the subject that empties into a superior mesenteric vein of the subject, (b) the mesenteric vein, and (c) the superior mesenteric vein, until a distal region of the electrode reaches the portal vein.

127. The apparatus according to any one of claims 109-116, wherein the electrodes are adapted to be applied to a hepatic branch of a vagus nerve of the subject, and to sense electrical activity of the hepatic branch.

128. The apparatus according to claim 127, wherein the electrodes are adapted to sense afferent impulses in the hepatic branch generated by the portoarterial glucose sensor.

129. The apparatus according to claim 127, comprising one or more signal application electrodes, adapted to be applied to the hepatic branch, wherein the control unit is adapted to:

responsively to detecting the eating, drive the signal application electrodes to apply a vagal electrical signal to the hepatic branch, and

configure the vagal signal current to reduce an appetite of the subject.

130. The apparatus according to claim 129, wherein the control unit is adapted to configure the vagal signal to mimic natural afferent nerve signals generated by the portoarterial glucose sensor.

131. The apparatus according to claim 129, wherein the one or more signal application electrodes comprise the one or more electrodes.

132. Apparatus for detecting eating by a subject, comprising:

a food intake detection device, adapted to be coupled to a hepatic portal vein of the subject, and to measure an indication of a concentration of at least one blood constituent in the portal vein, the constituent selected from the list consisting of: glucose, carbohydrate, fat, and protein; and

a control unit, adapted to:

analyze the concentration, and

responsive to the analysis, detect the eating.

133. The apparatus according to claim 132, wherein the food intake detection device comprises a chemical blood analysis device.

134. The apparatus according to claim 132, wherein the control unit is adapted to detect an indication of a composition of food eaten by the subject, responsive to the analyzing.

135. The apparatus according to any one of claims 132-134, wherein the food intake detection device comprises a non-chemical blood analysis device.

136. The apparatus according to claim 135, wherein the non-chemical blood analysis device is adapted to perform near-infrared or infrared absorption spectroscopy.

137. The apparatus according to claim 135, wherein the non-chemical blood analysis device comprises a laser transducer, adapted to measure acoustic reflections from blood in the portal vein.

138. The apparatus according to any one of claims 132-134, wherein the food intake detection device comprises a blood flow sensor, adapted to measure a rate of blood flow within the hepatic portal vein.

139. The apparatus according to claim 138, wherein the blood flow sensor comprises a blood flow meter.

140. The apparatus according to claim 138, wherein the blood flow sensor comprises one or more electrodes, adapted to be placed on an external surface of the portal vein, wherein the blood flow sensor is adapted to measure a change in impedance between the electrodes.

141. Apparatus comprising:

one or more electrodes, adapted to sense an electrical signal generated by a portoarterial glucose sensor of the subject; and

a control unit, adapted to:

analyze the signal, and

responsive to the analysis, detect an indication of a blood glucose concentration of the subject.

142. The apparatus according to claim 141, wherein the control unit is adapted to reduce an appetite of the subject responsively to detecting the indication of the blood glucose concentration.

143. The apparatus according to claim 141, wherein the control unit is adapted to reduce the blood glucose concentration responsively to detecting the indication of the blood glucose concentration.

144. The apparatus according to claim 141, comprising one or more signal application electrodes, adapted to be applied to at least one site selected from the list consisting of: a site in a vicinity of a colon of the subject, and a site in a vicinity of a distal small intestine of the subject, wherein the control unit is adapted to:

responsively to detecting the indication of the blood glucose concentration, drive the signal application electrodes to apply a stimulating electrical signal to the at least one site, and

configure the stimulating signal to stimulate L-cells to increase secretion of at least one hormone selected from the list consisting of: glucagon-like-peptide-1 (GLP-1) and peptide YY (PYY).

145. The apparatus according to any one of claims 141-144, wherein the control unit is adapted to increase a blood insulin level responsively to detecting the blood glucose concentration.

146. The apparatus according to claim 145, comprising an insulin pump, adapted to be applied to the subject, wherein the control unit is adapted to drive the insulin pump to supply insulin to a blood circulation of the subject.

147. The apparatus according to claim 145, comprising one or more signal application electrodes, adapted to be applied to a pancreas of the subject, wherein the control unit is adapted to:

drive the signal application electrodes to apply a pancreas electrical signal to the pancreas, and

configure the pancreas signal to increase insulin secretion.

148. The apparatus according to claim 145, comprising one or more signal application electrodes, adapted to be applied to a vagus nerve of the subject, wherein the control unit is adapted to:

drive the signal application electrodes to apply a vagal electrical signal to the vagus nerve, and

configure the vagal signal to cause an increase in insulin secretion by a pancreas of the subject.

149. The apparatus according to any one of claims 141-144, wherein the electrodes are adapted to be applied to a hepatic portal vein of the subject, and to sense electrical activity of the portal vein.

150. The apparatus according to claim 149, wherein the control unit is adapted to analyze the signal by detecting a decrease in the electrical activity of the portal vein.

151. The apparatus according to claim 149, wherein the control unit is adapted to analyze the signal by detecting an increase in the electrical activity of the portal vein.

152. The apparatus according to claim 149, wherein the control unit is adapted to analyze the signal by detecting changes in heights of different measured peaks of the electrical activity of the portal vein.

153. The apparatus according to claim 149, wherein the control unit is adapted to analyze the signal by detecting changes in relative timing of different peaks in the electrical activity of the portal vein.

154. The apparatus according to claim 149, wherein the electrodes are adapted to sense electrical activity of afferent nerve fibers that innervate the portal vein.

155. The apparatus according to claim 149, wherein the electrodes are adapted to be applied to an external surface of the portal vein.

156. The apparatus according to claim 155, wherein each of the electrodes comprises a wire shaped so as to define an arc of between about 270 and about 359 degrees, and wherein the electrodes are adapted to be applied around the external surface of the portal vein.

157. The apparatus according to claim 149, wherein the electrodes are adapted to placed in the portal vein.

158. The apparatus according to claim 157, wherein the electrodes comprise an electrode lead having a distal region and a proximal end, the electrode lead adapted to be placed in the portal vein by being advanced through: (a) an opening in a mesenteric vein of the subject that empties into a superior mesenteric vein of the subject, (b) the mesenteric vein, and (c) the superior mesenteric vein, until a distal region of the electrode reaches the portal vein.

159. The apparatus according to any one of claims 141-144, wherein the electrodes are adapted to be applied to a hepatic branch of a vagus nerve of the subject, and to sense electrical activity of the hepatic branch.

160. The apparatus according to claim 159, wherein the electrodes are adapted to sense afferent impulses in the hepatic branch generated by the portoarterial glucose sensor.

161. The apparatus according to claim 159, comprising one or more signal application electrodes, adapted to be applied to the hepatic branch, wherein the control unit is adapted to:

responsively to detecting the indication of the blood glucose concentration, drive the signal application electrodes to apply a vagal electrical signal to the hepatic branch, and

configure the vagal signal to reduce an appetite of the subject.

162. The apparatus according to claim 161, wherein the control unit is adapted to configure the vagal signal to mimic natural afferent nerve signals generated by the portoarterial glucose sensor.

163. The apparatus according to claim 161, wherein the signal application electrodes comprises the electrodes.

164. Apparatus comprising an electrode, which comprises a wire shaped so as to define an arc of between about 270 and about 359 degrees, the electrode adapted to be applied around an external surface of a vein.

165. The apparatus according to claim 164, wherein the vein includes a hepatic portal vein, and wherein the electrode is adapted to be applied around the external surface of the portal vein.

166. The apparatus according to claim 164, wherein the electrode comprises an electrically insulating coating that coats a portion of a circumference of the wire that does not come in contact with the external surface of the vein.

167. The apparatus according to claim 164, wherein the electrode comprises a removable curved needle, adapted to:

draw the electrode around the surface of the vein beneath at least a portion of connective tissue surrounding the vein, and

be removed after completion of the drawing.

168. Apparatus comprising:

a support structure; and

two or more electrodes coupled to the support structure, each of the electrodes comprising a wire shaped so as to define an arc of between about 270 and about 359 degrees, the electrodes adapted to be applied around an external surface of a vein.

169. The apparatus according to claim 168, wherein the vein includes a hepatic portal vein, and wherein the electrodes are adapted to be applied around the external surface of the portal vein.

170. The apparatus according to claim 168, wherein each of the electrodes comprises an electrically insulating coating that coats a portion of a circumference of the wire that does not come in contact with the external surface of the vein.

171. The apparatus according to claim 168, wherein each of the electrodes comprises a removable curved needle, adapted to:

draw the electrode around the surface of the vein beneath at least a portion of connective tissue surrounding the vein, and

be removed after completion of the drawing.

172. The apparatus according to any one of claims 168-171, wherein the support structure comprises an elongated rod.

173. The apparatus according to claim 172, wherein the rod has a length of between about 2 and about 3 cm.

174. The apparatus according to claim 172, wherein the rod has a length of between about 1 and about 3 mm.

175. Apparatus comprising:

an electrode lead having a distal region and a proximal end, the electrode lead adapted to be placed in a hepatic portal vein of a subject by being advanced through: (a) an opening in a mesenteric vein of the subject that empties into a superior mesenteric vein of the subject, (b) the mesenteric vein, and (c) the superior mesenteric vein, until a distal region of the electrode reaches the portal vein; and

a control unit, adapted to be coupled to the proximal end of the electrode lead, and to perform at least one action selected from the list consisting of: driving the electrode lead to apply an electrical current to the portal vein, and sensing electrical activity of the portal vein through the electrode lead.

176. The apparatus according to claim 175, wherein a portion of the electrode lead comprises an electrically insulating coating except at the distal region of the electrode lead.

177. The apparatus according to claim 175, comprising an external electrode, adapted to be placed external to the portal vein in a vicinity thereof, wherein the control unit is adapted to be coupled to the external electrode.